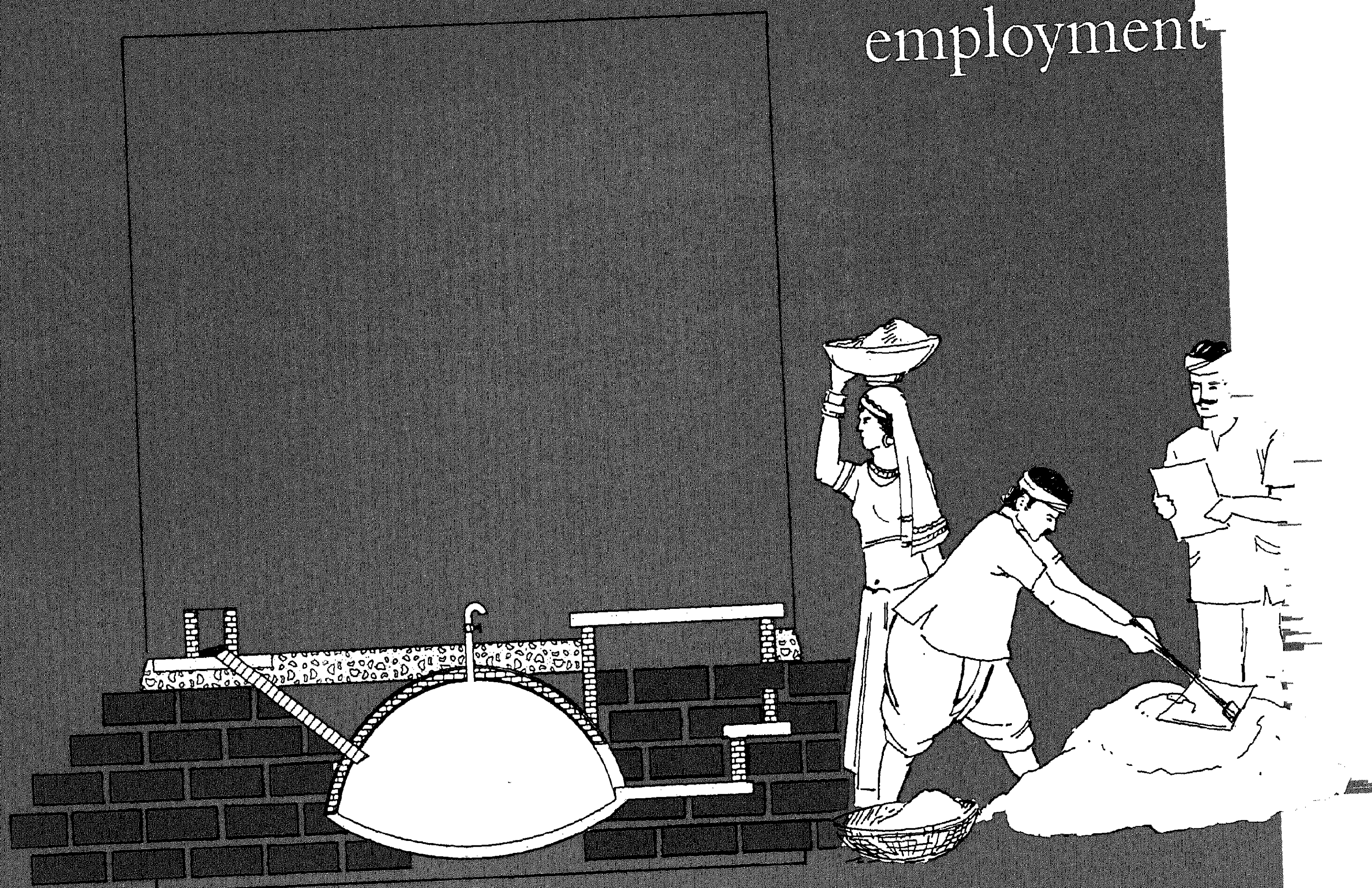
BIOGAS a source of rural employment



TATA ENERGY RESEARCH INSTIT

BIOGAS

a source of rural employment

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Ministry of Non-conventional Energy Sources

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In just over a decade, biogas has become one of the most important renewable energy technologies catering to the needs of the vast rural populace of India. More than 17.6 lac biogas plants have been set up so far under the National Project on Biogas Development (NPBD)—implemented by the Ministry of Non-conventional Energy Sources (MNES)—which have reached all parts of the country. After the initial teething problems faced by the programme, it has now stabilised and success rates have been steadily going up in several regions of the country. The approach of operating through turnkey workers, rural entrepreneurs and non-governmental organisations has made a significant contribution towards the success of NPBD. In the process, NPBD has also created wide employment opportunities in rural areas. With the new strategy of MNES focussing on providing market orientation to the promotion of renewable energy technologies including biogas, the role of turnkey entrepreneurs has become more important than ever before. Therefore, it is necessary to document the efficacy of this approach in NPBD, and identify the opportunities that exist for expanding the entrepreneurial base. This document is an effort in that direction.

What is biogas technology?

When any organic matter, such as cowdung, crop residue, and kitchen waste is fermented in the absence of oxygen, biogas is generated which contains combustible methane (around 60%) along with carbon dioxide, and traces of other gases. This gas can serve as a convenient fuel that can be used for a variety of applications, such as cooking, lighting, and motive power. The slurry that comes out of a biogas plant after the gas is produced, can be used as an organic manure in the fields to augment soil fertility. Thus, biogas technology produces fuel as well as fertilizer, while only one of these is possible if dung is used in its original form.

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Biogas production is a chemical process occurring in stages during which different bacteria act upon the organic matter resulting in the formation of methane and acids. The main factors that influence biogas production are pH (level of acidity) of the feedstock, and temperature. It is well established that a biogas plant works optimally at a pH level of 7 or just above (neutral solution), and a temperature of around 35°C. In low temperatures, bacterial activity slows down resulting in substantial decrease in gas generation, ceasing completely below 10°C.

Carbon-nitrogen ratio of the feed material is also an important factor and should be in the range of 20:1 to 30:1. Cowdung has a C-N ratio of 25:1 and is considered ideal for maximum gas production. Solid concentration in the feed material is also crucial to ensure sufficient gas production, as well as easy mixing and handling; 8–10% of total solids is the normal value required. Cowdung has a solid concentration of about 20%, and, therefore, it is recommended that dung and water are mixed in a 1:1 ratio to attain the desired level of solids. One kilogram of dung produces about 40 litres of biogas, and thus, in order to produce two cubic metres (2000 litres) of gas per day, which is required to meet the cooking needs of an average family of four to five members, a mix of 50 kg of dung and 50 litres of water should be fed into the plant everyday.

Hydraulic Retention Time (HRT)—the number of days the feed material is required to remain in the digester to begin gas production—is the most important factor in determining the volume of the digester which in turn

determines the cost of the plant; the larger the retention period, higher the construction cost. In India, different HRTs are recommended for three different temperature zones. For all the approved models under NPBD, the plant dimensions, requirement of materials for different digester capacities are available for different HRTs.

Zone	Average ambient temperature	HRT (days)	Approximate regions
I	> 20°C	30	Andhra Pradesh, Goa, Karnataka, Kerala, Maharashtra, Tamil Nadu, Pondicherry and Andaman & Nicobar Islands
II	15–20°C	40	Bihar, Gujarat, Haryana, Jammu region of J&K, Madhya Pradesh, Orissa, Punjab, Rajasthan, Uttar Pradesh and West Bengal
III	< 15°C	55	Himachal Pradesh, North-eastern states, Sikkim, Kashmir region of J&K, and Hill districts of UP

Benefits of biogas

Biogas technology, as mentioned earlier, makes optimal utilisation of the valuable natural resource of dung; it provides nearly three times more useful energy than dung directly burnt, and also produces nutrient-rich manure.

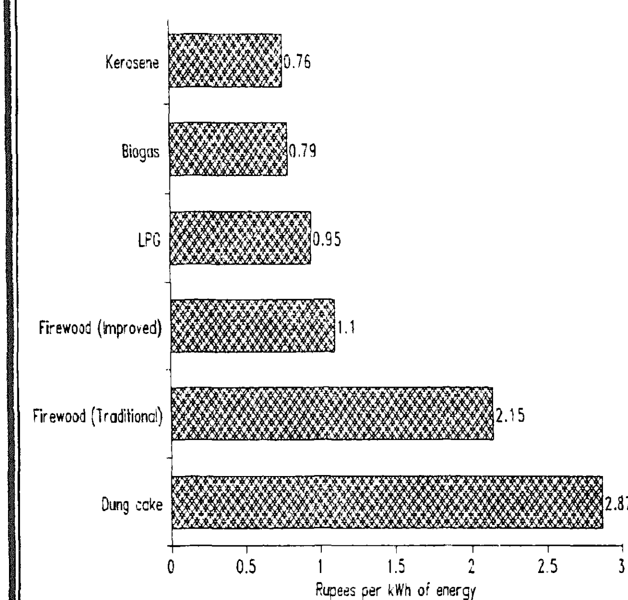
As a cooking fuel, it is cheap and extremely convenient. Based on the effective heat produced, a 2 cu m biogas

25 kg Fresh Dung

Direct Burning		*Biogas*
5 kg dry dung	Product	1 cu m biogas
10460 kCal	Gross energy	4713 kCal
10%	Device efficiency	55%
1046 kCal	Useful energy	2592 kCal
None	Manure	10 kg air dried manure

Biogas technology provides nearly three times more useful energy than dung directly burnt, and also produces nutrient-rich manure.

plant could replace, in a month, fuel equivalent of 26 kg of LPG (nearly two standard cylinders), or 37 litres of kerosene, or 88 kg of charcoal, or 210 kg of fuelwood, or 740 kg of animal dung. In terms of cost, biogas is cheaper, on a life cycle basis, than conventional biomass fuels (dung, fuelwood, crop wastes, etc.) as well as LPG, and is only fractionally more expensive than kerosene; the commercial fuels like kerosene and LPG, however, have severe supply constraints in the rural areas.



Cost of different cooking fuels (Rs per kWh of energy)

To the housewife, biogas is easy to use and saves time in the kitchen; biogas stove has an efficiency of about 55% which is comparable to that of an LPG stove. Cooking on biogas is free from smoke and soot, and can substantially reduce the kitchen related health problems, which are otherwise quite common in most rural areas in India where biomass is the chief source of fuel. Use of biogas also reduces the drudgery of women in gathering fuelwood. Thus, biogas ushers in an all-round improvement in the quality of life in the individual households.

To the housewife, biogas is easy to use and saves time in the kitchen.

However, the use of biogas is by no means confined to cooking alone. It can be used, through a specially designed mantle, for lighting, too. Further, biogas can partially replace diesel to run IC (internal combustion) engines for water pumping. This would not only reduce dependence on diesel which is mostly imported in India, but also help in reducing the carbon pollutants which adversely affect the atmosphere. Dual-fuel engines (80%

biogas and 20% diesel) are now commercially manufactured in India. Biogas can be similarly used to produce electricity, though this has not been attempted on a large scale in the country so far. Nevertheless, the versatility of biogas is its greatest advantage as a source of energy for the rural areas.

While biogas has multiple benefits at the individual family level, it also has several qualitative and quantitative benefits at the societal level. Firstly, a shift to biogas from traditional biomass fuels results in less dependence on natural resources such as forests, checking their indiscriminate and unsustainable exploitation. Since dung is collected systematically when used in biogas, the village environment can be kept clean and hygienic. The other advantage is that, unlike centralized systems such as thermal power plants and fertilizer factories, which entail huge capital investments and need elaborate distribution networks, biogas plants are decentralized systems which can be installed even in remote areas with very low investments. Thus, biogas technology has the potential not only to cater to different parts of the country, it can also create employment opportunities in the rural areas.

Potential of biogas

Large-scale dissemination of biogas plants began in India in the mid-seventies and the process became consolidated with the advent of the National Project on Biogas Development (NPBD) in 1981, which has been continuing since. By March 1993, more than 17.6 lacs of family size biogas plants have been installed in the field. Using this penetration level, and other factors governing the rural energy sector (demand for dung as manure, cattle-owning pattern, impact of other energy development programmes, etc.), the Ministry of Non-conventional Energy Sources (MNES) recently estimated the overall potential for biogas plants to be **120 lacs**, representing 10% of the total rural households in the country.

However, in terms of total dung that is available in the country, the potential is much more. The bovine population in India is 26 crores. An adult bovine produces an average of 10 kg of dung per day. Since grazing is a common practice in India, all the dung produced cannot be collected. If it is assumed that 75% of the dung is collected, nearly 20 lac tonnes of dung would be available

Cooking on biogas is free from smoke and soot, and can substantially reduce the kitchen related health problems.

Biogas has multiple benefits at the individual family level, it also has several qualitative and quantitative benefits at the societal level.

every day. At 25 kg per one cubic metre, this dung can feed as many as **400 lac** biogas plants of 2 cubic metre capacity, which can be considered the ultimate potential for biogas technology.

But even this high potential of biogas is based on animal dung only. As mentioned earlier, all organic matter can technically be used to generate methane; if the scientific experiments that are going on in the country under the patronage of MNES to develop alternative feedstocks (such as water hyacinth, kitchen waste, and poultry waste) come to fruition, potential for biogas generation could be virtually unlimited. It can be mentioned in this context that human waste is another excellent source of biogas which would enhance the potential substantially. With such high potential, which can be routed to hitherto unemphasised applications of shaft power and electricity generation, biogas can make a significant contribution to the development of small industries and agriculture, and thus to the overall advancement of the rural areas.

Biogas plant models

A typical biogas plant has the following components: i) a digester in which the organic matter mixed with water is fermented; ii) an inlet tank used to mix the feed and let it into the digester; iii) a gas holder in which the generated gas is collected; iv) an outlet tank to remove the spent slurry; and v) distribution pipeline(s) to take the gas into the kitchen.

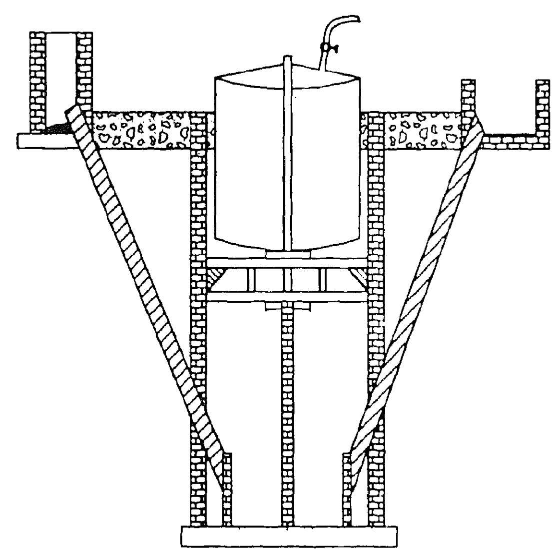
Under the National Project on Biogas Development (NPBD), there are various biogas plant models approved by MNES for implementation. All these models are based on one of the two basic designs available, floating metal drum type and fixed masonry dome type. Recently, however, a new portable model, *FLXI*, made of rubberised nylon fabric, has been approved for promotion in the hilly and other rough terrains. Presently the MNES approved models are as follows.

KVIC floating drum
Janata
Deenbandhu
Pragati
KVIC plant with ferrocement digester
KVIC plant with Fibre Reinforced Plastic Gas Holder
FLXI

The main features of each of these models are presented below:

KVIC floating drum. This model was developed in the early sixties by Khadi and Village Industries Commission (KVIC). The design was based on *Gramalakshmi III*, the first workable prototype of a biogas plant, developed by Jashbhai Patel, a Gandhian worker from Gujarat, in the early fifties. This model has an underground cylindrical digester with inlet and outlet connections at the bottom on either side of a masonry wall. An inverted metal drum which serves as the gas holder rests on a wedge type support on top of the digester. The diameter of the steel drum is smaller than that of the digester and as the gas begins to accumulate, the drum starts rising in height. The weight of the drum applies pressure on the gas to make it pass through the pipeline to the point of use. As the gas flows out, the drum gradually moves down. Due to this smooth two-way motion, the gas remains at constant pressure which ensures efficient use of gas.

Line sketch of *KVIC* biogas plant



Technically all organic matter can be used to generate methane; hence, potential for biogas generation could be virtually unlimited.

Though *KVIC* has been a very popular model since the beginning, it has two major drawbacks. Firstly, the plant cost is very high, and secondly, the metal gas holder has to be painted regularly for protecting it against corrosion which means a high recurring cost. With the development of cheaper models over time, the presence of *KVIC* model is gradually diminishing in NPBD.

Average cost of a *KVIC* plant (Rs)			
Plant capacity (m^3)	30 days HRT	40 days HRT	55 days HRT
1	7600	8500	11900
2	10500	11700	16500
3	14200	15700	22000
4	16300	18100	25400

Deenbandhu has probably been the most significant development in the entire biogas programme.

Janata. This model, based on the Chinese fixed dome design, was developed in 1978 at Gobar Gas Research Station, Ajitmal, in Uttar Pradesh. In this model, the gas holder and the digester are combined into one brick and cement structure. The main attraction of *Janata* has been its low cost, it is 20–30% cheaper than *KVIC* plant. Since it is built underground, it has better insulation from varying temperatures. In the initial years, *Janata*, along with *KVIC* model, was the mainstay of NPBD.

However, *Janata* model suffers from certain disadvantages—it is important to ensure high quality of building materials and construction, so as to avoid dome breakage and consequent gas leakage. In the initial years of NPBD, *Janata* plants had a high failure rate due to poor quality construction. In fact, with the advent of the cheaper fixed dome model, *Deenbandhu*, in the mid-eighties, it has become confined to a few geographical pockets though it continues to remain in the list of approved models. (Average cost of *Janata* model is given in table on following page.)

Deenbandhu. *Deenbandhu* model was developed in 1984, by Action for Food Production (AFPRO), a voluntary organisation based in New Delhi. *Deenbandhu* has probably been the most significant development in the

Average cost of a *Janata* plant (Rs)	
Plant capacity (m^3)	55 days HRT
2	11500
3	14000
4	17000

Average cost of a *Deenbandhu* plant (Rs)		
Plant capacity (m^3)	40 days HRT	55 days HRT
1	5800	8100
2	6800	9400
3	8200	11500
4	10500	14800

entire biogas programme of India as it reduced the cost of the plant to almost half that of *KVIC* model, and brought biogas technology within the reach of even the poorer sections of the population. The cost reduction has been achieved by minimizing the surface area through joining the segments of two spheres of different diameters at their bases. This structure acts as digester as well as gas storage chamber. Once the gas collects in the digester, pressure is exerted on the slurry which is pushed into a displacement chamber. Once the gas is drawn out from the outlet, the slurry again enters the digester. The brick masonry dome, which is fixed, requires skilled workmanship and quality material to ensure no leakages.

Pragati. Designed by United Socio-economic Development and Research Programme (UNDARP), an NGO based in Pune, *Pragati* model was approved under NPBD in 1987. This model is a combination of *KVIC* and *Deenbandhu* designs. The lower part of the digester is semi-spherical in shape with a conical bottom. However, instead of a fixed dome, it has a floating drum acting as gas storage chamber. The spread of *Pragati* model has been confined mainly to the state of Maharashtra.

Average cost of a *Pragati* plant (Rs)	
Plant capacity (m^3)	55 days HRT
2	13500
3	17000
4	20000

The spread of Pragati model has been confined mainly to the state of Maharashtra.

Ferrocement plants offer several advantages like 10–15% reduction in cost over KVIC digesters, usage of locally available material and less labour, and little or no maintenance.

Ferrocement digester. In order to overcome the problems encountered in construction of traditional models of biogas plants, alternative construction materials have been tried out and ferrocement is but one of them. Ferrocement is nothing but reinforced concrete made of welded mesh, sand, and cement. Layers of thin steel wire mesh distributed throughout the thickness of element, are impregnated with rich mortar. Ferrocement as a building material offers several advantages like 10–15% reduction in cost over *KVIC* digesters, usage of locally available material and less labour, and little or no maintenance. The only limitation suffered by ferrocement is damage due to impact by pointed loads, which however can be easily repaired. The *ferrocement* digester design approved under NPBD has been developed by Structural Engineering Research Centre, Ghaziabad.

Fibre Reinforced Plastic (FRP) Gas Holder. FRP has been used in the place of metal in the floating drum gas holder. Contact Moulding Process, a technique of moulding without the application of external pressure, is adopted to manufacture the FRP. It employs one of the less expensive types of moulds resulting in lower cost for the plant. The major advantage of FRP is its good resistance to corrosion which saves the recurring expenditure on painting the drum.

FLXI. This is a portable model in which the digester is made of rubberised nylon fabric, developed by Swastik Rubber Products Ltd, Poona. The model is particularly suitable for hilly areas where high transportation cost of construction materials, such as cement and bricks substantially increases the cost of installing the regular type of biogas plants.

Average cost of a *FLXI* plant (Rs)

Plant capacity (m^3)	55 days HRT
1	9450
2	14000
3	17300
4	25000

Biogas programme in India

Though biogas technology was known to India nearly a hundred years ago, the actual dissemination of biogas plants in the field began, that too on a pilot scale, only in the early sixties, with the initiative of KVIC (Khadi and Village Industries Commission). The government of India took interest in biogas as a possible alternative to traditional biomass fuels in the rural areas, in the wake of the energy crisis of early seventies, and launched a dissemination programme to be run by Ministry of Agriculture. By early eighties these efforts resulted in the installation of more than 100 000 biogas plants in the field. At the same time, realisation of the growing rural energy scarcity and its effect on the environment necessitated search for viable technology options on the part of the policy makers, and biogas was considered mature enough to be one such alternative. Thus, in 1981 the National Project on Biogas Development (NPBD) was formally launched.

Evolution of biogas technology in India

1897	Biogas used for lighting at Matunga leper asylum, Bombay
1937	Commissioning of Dadar sewage purification plant, Bombay
1946	First family-size biogas plant designed at Indian Agricultural Research Institutute, Delhi
1952	Development of the floating drum model *Gramalaxmi III*
1961	Establishment of Gobar Gas Research Station (GGRS) at Ajitmal, Uttar Pradesh
1962	KVIC's entry into the field of biogas technology
1977	Development of *Janata* biogas plant by GGRS
1981	Launching of NPBD (National Project on Biogas Development)
1982	Shifting of NPBD to DNES; inclusion of biogas in the Prime Minister's 20-Point Programme
1984	Development of low cost *Deenbandhu* design
1992	Development of *FLXI* model for rough terrains; conversion of DNES into Ministry
1993	New thrust on market orientation for biogas dissemination

The FLXI portable model is particularly suitable for hilly areas where high transportation cost of materials substantially increases the cost of installing the regular type of biogas plants.

National Project on Biogas Development (NPBD)

NPBD began with an outlay of Rs 50 crores as a part of the VI Plan. To provide impetus to the programme, it was included in the Prime Minister's Twenty Point Programme, and brought under the purview of the newly formed Department [now Ministry] of Non-conventional Energy Sources (MNES) in 1982.

The government of India took interest in biogas as a possible alternative to traditional biomass fuels in the rural areas.

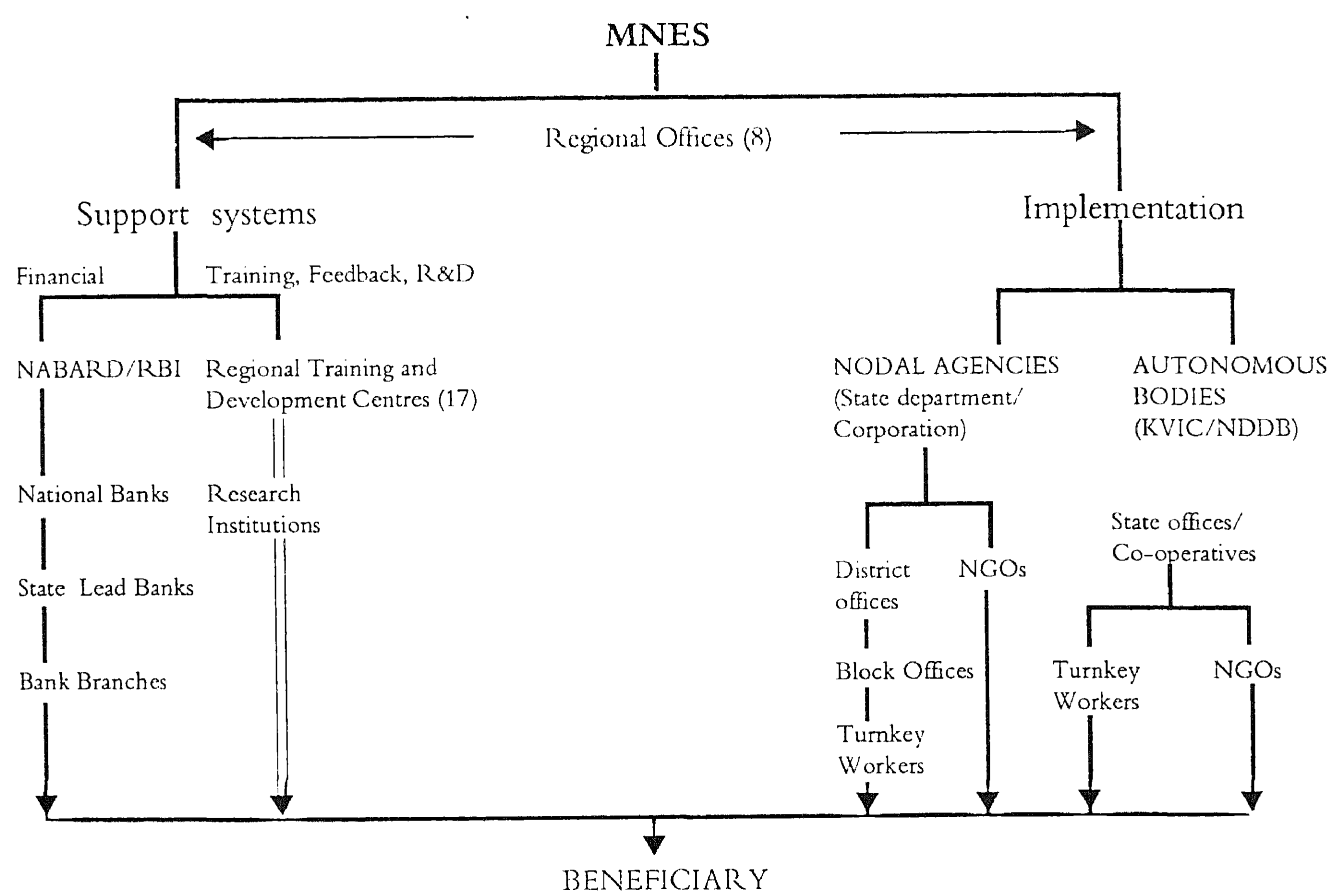
Objectives of National Project on Biogas Development

- To provide energy in a clean, unpolluting form
- To make available enriched fertilizer as a by-product for supplementing and optimizing the use of chemical fertilizers
- To reduce pressure on dwindling fuelwood supplies and prevent indiscriminate deforestation
- To eliminate the smoke-filled cooking environment, reduce drudgery, and prevent eye diseases
- To bring about an improvement in rural sanitation

Institutional arrangements

Under NPBD, the Ministry adopted a decentralized multi-agency, multi-model implementation strategy wherein a number of organisations and institutions have been involved in the programme at different levels. For each state, a nodal department (Department of Rural Development, Agriculture, Science and Technology, etc.) is nominated which coordinates the activities under NPBD. The actual implementation is done by state nodal agencies designated for the purpose. Nodal agencies can be state departments, corporations of the state governments or energy development agencies. However, autonomous institutions like KVIC and National Dairy Development Board (NDDB), and non-governmental organisations like All India Women's Conference (AIWC) have also been designated as implementing agencies with separate annual targets. Thus, there can be more than one implementing agency in a state—for instance, in Gujarat, NPBD is implemented by Gujarat Agro-Industries Corporation (GAIC), KVIC, NDDB and Aga Khan Rural Support Programme (AKRSP). At the district and lower levels, the implementing agencies often involve—apart

STRUCTURE OF NPBD



from government bodies like DRDA and BDO—rural voluntary organisations, turnkey entrepreneurs, and other grassroots level institutions like *gram panchayats,* dairy co-operatives, etc.

Financial arrangements

Bank loans at nominal interest rates are made available for biogas beneficiaries to meet the part of the cost not covered by the subsidy.

The task of target setting and disbursement of funds is done by MNES at the central level. At the beginning of every year, targets for number of plants to be installed would be fixed for each state/UT depending on the size of the state, achievement of the previous year, past performance record, etc. Based on the targets allotted, 50% of the estimated outlay is given in advance to the programme implementing agencies at the state level. The rest 50% is released after completion of 25% of the total physical targets, and the final settlement for the financial year is made based on the claims of the implementing agency for additional target or pending amounts.

The state level targets are further disaggregated at district and block levels. Different programme implementing agencies have different mechanisms for the disbursement of funds to their lower level functionaries according to the targets. The funds thus advanced cover, apart from the subsidy, the expenditure on components like service charges, turnkey job fees, and promotional incentives. Separate funds are also allocated and given in advance for a fixed number of training courses for different categories at approved rates.

To encourage adoption of the technology, a part of the biogas plant cost is given to the beneficiary in the form of subsidy by MNES. For this, MNES has devised an elaborate subsidy pattern for different categories of people taking into account physical disparities existing in different parts of the country. In the initial years of NPBD, the subsidy was fixed so as to meet a substantial part of the total cost. However, as the biogas technology has spread and gained more and more acceptability, the subsidy amounts have gradually been reduced to the present level of less than one-third of the cost. But, some state governments like Karnataka and Gujarat provide an additional subsidy to the beneficiaries.

Subsidy pattern under NPBD (Rupees)

Capacity of plant (m^3/day)	NE region states excluding plains of Assam, Sikkim, J&K, HP, and 8 hilly districts of UP (excluding terai regions of two hilly districts), Andaman & Nicobar Islands, Lakshadweep	SC/ST, desert districts, small and marginal farmers, landless labourers, plain areas of Assam, terai region of two hilly districts of UP, Western Ghats and other notified hilly areas	All others
1	2800	2000	15000
2	3200	2400	1800
3 & 4	3500	2600	2000

Bank loans at nominal interest rates are also made available for biogas beneficiaries to meet the part of the cost not covered by the subsidy. Each state has a designated lead bank which coordinates the loaning facilities within the state. At the central level, the overall coordination is carried out by the National Bank for Agriculture and Rural Development (NABARD).

When a commercial bank finances biogas plants, a fixed percentage of the total loan amount sanctioned in a year is reimbursed to it by NABARD under 'Automatic Refinancing Scheme'.

Various incentives under NPBD

- Service charges are paid to nodal agencies and other implementing agencies to support their staff depending on the target.
- Rs 500 is paid as turnkey fee for each biogas plant for construction and warranty for three years maintenance; additional fee of Rs 150 is paid per plant connected to sanitary toilet.
- Rs 50 is paid per plant to the village level functionaries or approved workers who act as motivators and facilitators.
- Special allocation to conduct staff orientation courses (Rs 5 per plant); refresher/ construction-cum-maintenance training courses (Rs 9000 per course); users' training courses (Rs 5 per plant); and turnkey workers' training courses (Rs 30 000 per course).
- Funds are provided for setting up demonstration plots using biogas slurry manure.
- Special incentive of up to 50% of the cost, with a ceiling of Rs 2500, is given to convert diesel engine to dual-fuel mode (80% biogas and 20% diesel), besides a subsidy of Rs 2500 for plants of 6 to 10 m^3 capacity installed for operating dual-fuel engines.
- Funds are allocated for awareness campaigns through radio, TV, print media, fairs and exhibitions, etc., varying from Rs 100 000 to Rs 500 000 depending on the target.
- Gold and silver shields are given to states and districts for outstanding achievements in different categories.

Regional Biogas Development and Training Centres	States/UTs covered
AP Agricultural University, Hyderabad	Andhra Pradesh
Assam Agricultural University, Jorhat	Assam and North-eastern States
Rajendra Agricultural University, Pusa Samastipur	Bihar
Gujarat Agricultural University, Anand	Gujarat, Dadra and Nagar Haveli, Daman and Diu
HP Krishi Vishwa Vidyalaya, Palampur	Himachal Pradesh, Jammu & Kashmir, Chandigarh
University of Agricultural Sciences, Bangalore	Karnataka
Kasturbagram Krishi Kshetra, Indore	Madhya Pradesh
Centre of Science for Villages, Wardha	Maharashtra (Marathwada and Vidarbha)
Institute of Renewable Energy, Nasik	Maharashtra (except Marathwada and Vidarbha), Goa
Orissa University of Agriculture and Technology, Bhubaneshwar	Orissa
College of Technology and Agricultural Engineering, Udaipur	Rajasthan, Delhi
TN Agricultural University, Coimbatore	Tamil Nadu, Pondicherry, Lakshadweep
Regional Institute of Rural Development, Ghazipur; Gurukul Kangri (sub-centre of RIRD), Haridwar	Uttar Pradesh
Indian Institute of Technology, Kharagpur	West Bengal, Andaman and Nicobar Islands
Department of Agriculture, Thiruvananthapuram	Kerala
Haryana Agricultural University, Hissar	Haryana
Punjab Agricultural University, Ludhiana	Punjab

Support infrastructure

In order to provide different kinds of support to the implementation structure, MNES has created a network of seventeen Regional Biogas Development and Training Centres (RBDTCs) in the country. These centres impart training and provide technical backup to various groups of people involved in the implementation, and also carry out research and development work on different aspects of biogas technology. In order to provide close guidance to the state nodal agencies, and monitor the progress of the programme, eight Regional Offices of MNES have been set up.

Today, biogas has reached literally every nook and corner of the country, and has registered its presence even in remote areas like Andamans and Arunachal Pradesh.

MNES Regional Offices	
• Chandigarh	• Lucknow
• Bhopal	• Madras
• Guwahati	• Ahmedabad
• Hyderabad	• Bhubaneshwar

Apart from these, a large number of universities, academic and research institutions, regional research laboratories, etc., are involved in carrying out research and development activities under the sponsorship of MNES to study the microbiological aspects of biogas production, and development of alternative feedstocks, and cheaper construction materials.

Monitoring and feedback

In order to receive reliable feedback on the operational aspects so that the implementation process can be continually improvised, MNES has created mechanisms at various levels involving different categories of people.

The respective nodal departments send in claims on biogas plants actually commissioned, in order to receive the subsidy amount from MNES. So as to ensure that correct reporting is done from the ground level, the Block Level Officer is expected to physically verify 100% of the installed plants, District Level Officer 5–10%, and State Level Officer 1–5% of the plants.

The state governments and implementing agencies also have the responsibility to identify the dysfunctional plants

and have them rectified by, if necessary, organising special training and refresher courses for users and staff. A quarterly report on the status of revival of dysfunctional plants is submitted to MNES.

In addition, the Regional Offices of MNES have the responsibility of surveying 100% plants in a block of a district selected on a random basis. RBDTCs have similar targets for inspection. Nodal departments, agencies, KVIC, etc., provide requisite assistance in carrying out these inspections.

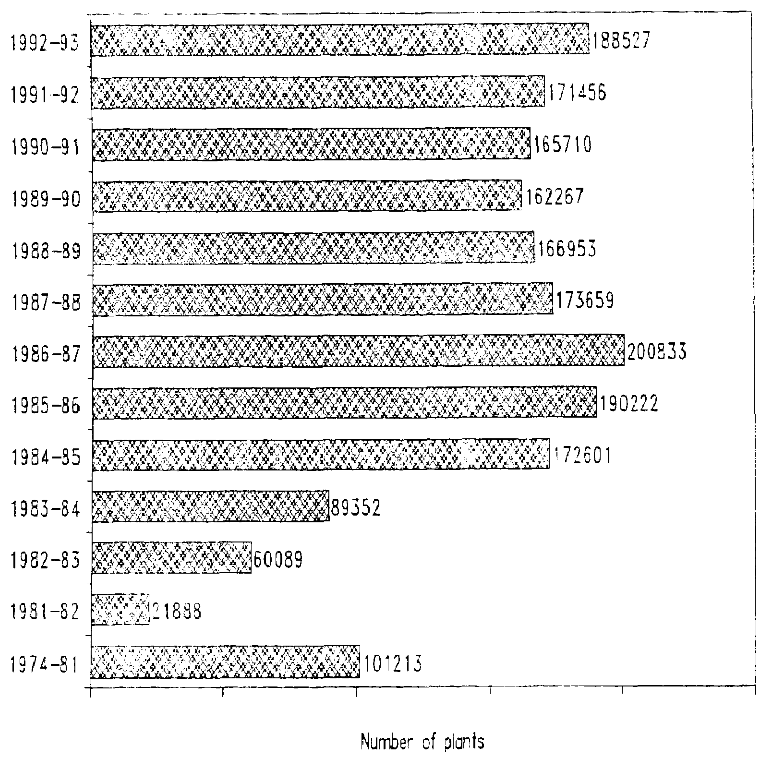
An effective system for collecting information, providing feedback and carrying out performance monitoring, has been devised involving turnkey workers, field functionaries, and officers of the nodal agencies at block, district and state level, to ensure quick remedial action for improving the overall functionality of plants. Apart from this, the officers of MNES headquarters as well as Regional Offices also carry out random sample inspections to study the operational performance of the plants and suggest improvement measures.

In addition to the surveys thus conducted by various officials directly involved in NPBD, independent research and academic organisations are also commissioned by MNES periodically to carry out evaluation studies and specific case studies.

Progress of NPBD

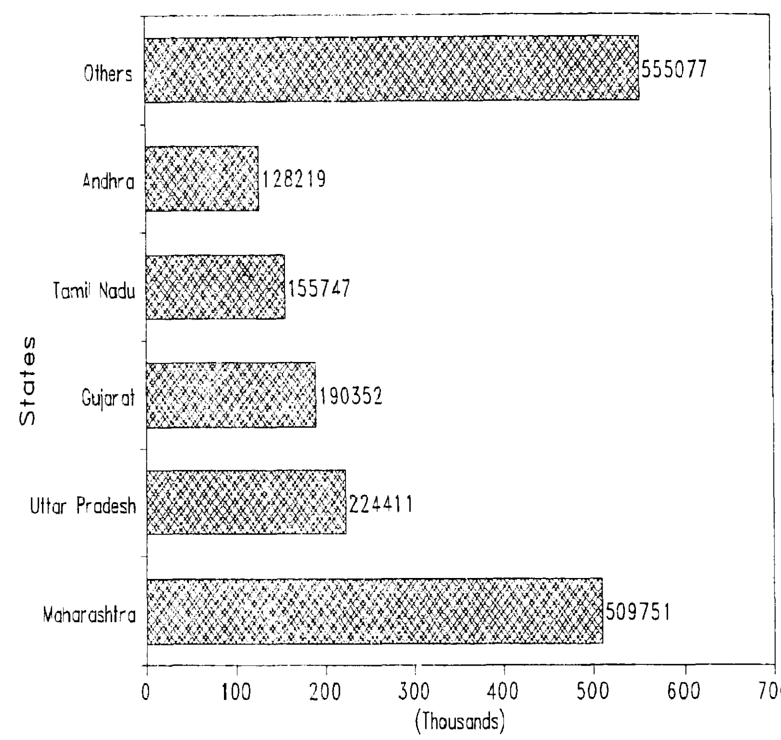
NPBD is twelve years old by now, and during this period, it has grown quite rapidly in size as well as stature. Since its beginning, NPBD has always met the set targets every year and even exceeded them, and by March 1993 the total number of plants installed has crossed 17.6 lacs. Today, biogas has reached literally every nook and corner of the country and has registered its presence even in remote areas like Andamans and Arunachal Pradesh.

Progress of NPBD



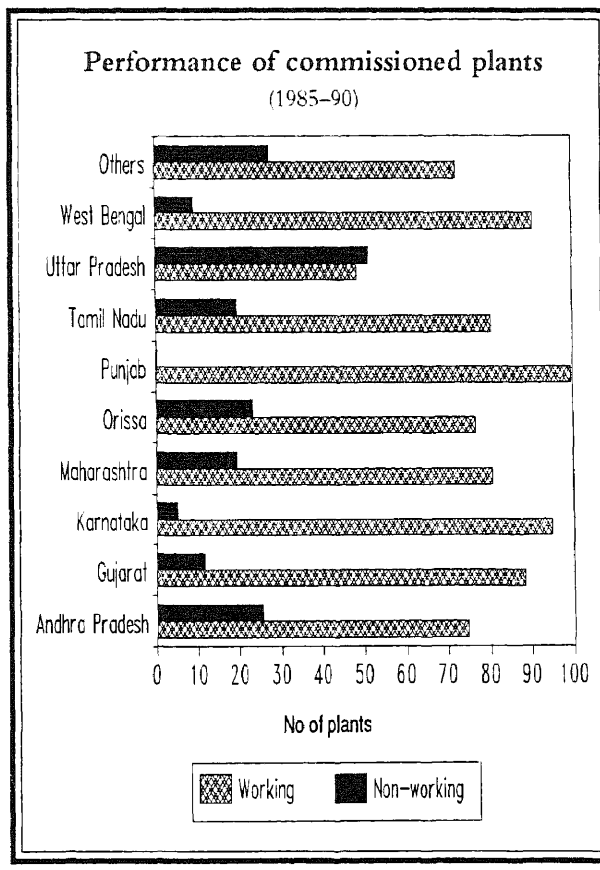
Achievements in NPBD

(Cumulative up to 1992–93)



Maharashtra is the leading state accounting for nearly one-third of the total plants installed under NPBD, and it is followed by Uttar Pradesh, Gujarat, Tamil Nadu and Andhra Pradesh. Though most of the major states have installed different approved models, there was a predominance of *Janata* in Uttar Pradesh in the initial years, while *Pragati* model has been promoted mainly in Maharashtra. But on the whole, it is *Deenbandhu* which has become the popular model with most states adopting it. One heartening development is the entry of biogas into North-eastern states and other hilly regions such as Himachal Pradesh, and Garhwal and Kumaon hills of Uttar Pradesh. The spread into these environmentally sensitive regions is further accentuated by the introduction of *FLXI* model.

The functionality rates in NPBD have been quite high as has been revealed in the recent nation-wide evaluation study conducted by the National Council for Applied Economic Research (NCAER). According to this, over 77% of the plants commissioned during the Seventh Plan (1985–90) were functioning. Punjab, Karnataka and West Bengal have had particularly high success rates exceeding 90%. Maharashtra and West Bengal have also installed a considerable number of toilet-linked biogas plants.



Maharashtra is the leading state accounting for nearly one-third of the total plants installed under NPBD.

Achievements

Perhaps, the most important benefit of NPBD has been its contribution to the improvement of quality of life in rural areas, especially of the womenfolk.

In the course of twelve years, NPBD has chalked up several achievements to its credit. The 17.6 lac plants that have been set up so far are estimated to produce energy equivalent of over 55 lac tonnes of fuelwood annually, in terms of useful heat provided, and also generate over 250 lac tonnes of manure (NPK). Thus, NPBD is believed to effect an annual saving of nearly Rs 420 crores in terms of reduced fuelwood demand and fertilizer substitution.

The other notable achievement of NPBD is the employment opportunities it has created in the rural areas. Apart from providing regular means of livelihood to several turnkey operators and entrepreneurs, it has given employment to a large number of masons, motivators and manual labourers. As an estimate, NPBD has generated employment equivalent to 80 million man-days so far.

But, perhaps, the most important benefit of NPBD has been its contribution to the improvement of quality of life in rural areas, especially of the womenfolk. Wherever biogas plants have been installed, they have replaced the traditional fuels to a large extent in the fuel consumption pattern, in the process eliminating the negative impacts associated with the use of traditional fuels. Apart from the fuel substitution, smokelessness, time saving and cleanliness offered by biogas are the qualitative factors that have greatly impressed the rural housewives. Studies have shown that sharp decreases have been registered in the use of kerosene, fuelwood and dung-cakes across the states following the installation of biogas plants.

In order to cater to the weaker sections of rural population who do not possess sufficient number of cattle, MNES has promoted 1 m^3 plants to meet at least partial needs of these households. This measure has benefitted the users substantially as they comprise that section of population which uses traditional fuels the most.

NPBD has also made a major contribution in the ecologically fragile regions of the country. Special efforts have been made to promote biogas in areas such as Sunderbans of West Bengal, Garhwal and Kumaon hills of Uttar Pradesh, and Jhabua district of Madhya Pradesh, where fuelwood use has become environmentally destructive

owing to severe degradation that has already taken place. A major success in this regard has been achieved in and around the Gir Lion Sanctuary in Gujarat where biogas has helped substantially reduce fuelwood demand in the buffer zone giving a major boost to the wildlife conservation.

In recent times, the value of biogas slurry as manure has also been well recognised, and in some places like Surendranagar district in Gujarat, which has poor quality soil, biogas is promoted prominently as a soil enricher. The Agricultural University in Coimbatore has developed a method to make pellets from the slurry to be used as fertilizer more efficiently. Slurry has also been found to be a good fish feed, used in pisciculture in West Bengal.

Thus, the impressive spread and success of the biogas programme has resulted in both quantitative and qualitative benefits to the individual families as well as the society.

Turnkey approach—cornerstone of NPBD

In the multi-agency set up of NPBD, a large number of organisations operate at the field level adopting different strategies. However, many of them function through a network of turnkey workers (TKW) at the village level who install biogas plants for beneficiaries on a turnkey basis. Though it has been an integral part of the implementation strategy in NPBD right from the beginning, the turnkey approach has taken deep roots in recent years, and has attracted diverse groups of people such as non-governmental organisations and private entrepreneurs. into the fold of the biogas programme. By now, turnkey approach has emerged as one the most important factors contributing to the success of NPBD.

NPBD has made a major contribution in the ecologically fragile regions of the country.

Functions of TKWs

A TKW is responsible for the entire process of biogas plant installation including motivating the beneficiary, arranging subsidy and loan, constructing the plant,

A major success has been achieved in and around the Gir Lion Sanctuary in Gujarat where biogas has helped substantially reduce fuelwood demand in the buffer zone giving a major boost to the wildlife conservation.

commissioning, and ensuring a trouble-free functioning of the plant for a stipulated period of three years. TKWs work at the village level with the beneficiaries and hence provide the necessary linkage between the implementing agency and the individual beneficiary. In fact, in the whole set up of NPBD, TKW is the only one who comes in direct contact with the beneficiaries at all the stages of installation.

In terms of motivating the beneficiaries, the practice adopted varies from place to place. In some areas, TKWs themselves go and contact potential beneficiaries while in others, they engage some unemployed youth in the villages to carry out this task at a nominal fee per plant. In high potential areas, TKWs sometimes employ people as motivators on a regular wage. However, the task of motivation becomes less and less important as more and more people adopt the technology, due to 'demonstration effect'.

Once a potential beneficiary agrees to get a plant installed, the TKW helps him to fill a questionnaire with details like number of cattle owned, space availability, income level, etc. This questionnaire is then passed on to the implementing agency for approval. Following this, if the beneficiary requires a loan, his papers are passed on to the local lead bank for sanction; construction work is begun only after the loan is sanctioned. In some states, the construction material is procured by the beneficiary himself with guidance from TKW. While in others, the initial investment for the material is made by TKW in which case, a minimum capital base becomes an informal eligibility criterion to become a turnkey worker.

Actual construction work is carried out by trained masons under the supervision of TKW. Number of plants a TKW constructs depends upon the number of masons he engages.

Once a plant is commissioned, the TKW has to look after the maintenance of the plant for three years to ensure trouble-free functioning. Usually, cost of minor repairs is taken care of by the beneficiary with technical guidance from TKW. However, major problems arising out of construction faults will have to be dealt with by TKW investing his own money.

Who can become a TKW ?

Though the profile varies across the country, a typical turnkey worker could be a mason involved in construction work in a cluster of villages, or a manufacturer of accessories for stoves and agricultural equipments. Unemployed or partially employed persons in the rural areas can also take up the activity. Experience in masonry work will be helpful, though not absolutely necessary.

Apart from individuals, turnkey jobs can also be undertaken by non-governmental organisations (NGOs), other registered societies and private entrepreneurs. Presently a large number of such organisations function as turnkey operators. For instance, Aga Khan Rural Support Programme in Gujarat is a voluntary organisation which was working as a turnkey agency (it has now become an implementing agency receiving separate annual targets); Gram Vikas in Orissa is a similar example. An NGO can make use of its existing infrastructure for biogas dissemination at a very small additional cost.

To become a turnkey worker or agency, one has to register the name with the district or block level governmental/non-governmental agency which is implementing NPBD. Only after this registration, will the TKWs be allotted yearly targets. The size of the target allotted to an individual TKW depends primarily on the overall target for a specific geographical area, and the number of TKWs operating in that area.

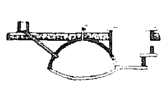
Financial incentives for TKWs

As already mentioned, TKW is entitled to a turnkey job fee of Rs 500 per every plant commissioned for which he has to offer a three year warranty. A part of the turnkey fee is paid immediately after commissioning the plant, and the rest after the warranty period. During this period, he has to visit each plant on a periodic basis as well as rectify, at his own cost, any structural defect not arising out of the beneficiary's fault. An additional Rs 150 is also paid if the plant is connected to sanitary toilet, which has to be run for at least two years. There is also a provision to connect the already existing plants to toilets for which turnkey fee will be paid.

By acting as motivators/promoters for identifying the beneficiaries, TKWs can also claim Rs 50 per plant as incentive. In large operation by turnkey organisations, this incentive can be passed on to their workers.

Training for TKWs

Once TKWs are registered, they have to undergo a basic training course specially designed for them, before they can take up actual installation work. This course is conducted by the implementing agencies in association with the respective Regional Biogas Development and Training Centres (RBDTCs). An amount of Rs 30 000 is sanctioned by MNES for every such training course. Apart from this, refresher/ construction-cum-maintenance courses for professional masons are also conducted periodically to deal with specific problems, etc. which again is funded by MNES to the extent of Rs 9000 per course.



The success of turnkey approach

The turnkey approach has by now gained popularity in several states like Maharashtra, Gujarat, Andhra Pradesh, Tamil Nadu and Orissa. Considering that these are the states where NPBD has been performing exceptionally well, it is clear that TKW has become the mainstay of NPBD.

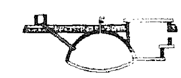
To illustrate the above point, some success stories can be considered. For instance, the good performance of biogas programme in Gujarat can be largely attributed to the decentralised turnkey approach adopted by the implementing agencies. Gujarat Agro Industries Corporation (GAIC) has created a separate cadre known as SEBGSs (Self Employed Bio Gas Supervisors), who act as TKWs. GAIC has stipulated that the number of plants constructed by an individual TKW should not exceed 200 in a year so as to prevent dilution of quality of work. Apart from ensuring reasonable income for this cadre, GAIC also employs means such as routine inspections, mobile motorcycle units, and post card surveys of beneficiaries to monitor their functioning.

KVIC, on the other hand, has promoted turnkey installation of biogas plants as a profitable commercial venture, so that the TKWs have an incentive to make conscious efforts to keep the beneficiaries satisfied. A TKW, who on an average installs 200 plants in a year has to ensure good post- installation service if he is to motivate more villagers to install biogas plants.

In certain parts of Maharashtra like Kolhapur, biogas programme promoted through TKWs has performed so well that people are now prepared to install biogas plants by investing their own money even if loans and government subsidies are not available.

In Andhra Pradesh, too, turnkey approach has begun to pay handsome dividends for the biogas programme. Districts like Khammam and West Godavari now boast functionality rates in excess of 90% with an ever growing demand for biogas plants in the agriculturally-prosperous villages.

The efficacy of this approach has become so evident now that even women have come forward to become TKWs in some parts of the country. For instance, Kasturbagram Krishi Kshetra, Indore, has successfully motivated a large number of tribal women in Jhabua district of Madhya Pradesh to adopt biogas technology, and trained them in plant construction, some of whom have now taken up turnkey installation of biogas plants on a commercial basis. There are a number of women entrepreneurs operating in Tamil Nadu also, trained by RBDTC, Coimbatore.



The success of the turnkey approach can also be seen in the role NGOs are playing in the implementation of NPBD. Several of them have taken up biogas dissemination on a large scale at the grassroots level. Some NGOs have also been involved at the state level, in coordinating the dissemination activities along with government agencies. MYRADA in Karnataka, Gram Vikas in Orissa, Grama Siri in Andhra Pradesh are some examples of NGOs which have taken up biogas programme as a major activity.

There are several more instances that can be given to illustrate the positive features of the turnkey approach. But what are the factors responsible for its success ?

Quality of construction. The fact that TKWs have a direct stake in the performance of the biogas plants they have installed, has made a considerable impact on the quality of construction and consequently the functionality.

Economies of scale. Most TKWs operate in a cluster of contiguous villages which helps in effective monitoring as well as cost saving in transportation of construction material. Materials are often procured in bulk which results in monetary saving and also ensures even quality.

Entrepreneurial spirit. By reducing emphasis on subsidy and encouraging enterprise in the dissemination process through turnkey approach, NPBD is gradually transforming the perceptions stemming from mistrust towards the subsidy-driven programme. An appreciation of the technology on its own merit will be the best guarantee for the success of the programme in the long run.

Commitment. The close proximity and commitment of NGOs and other TKWs to the welfare of the common people has also been a major contributing factor in the effective implementation of the programme.

Entrepreneurship in NPBD—a case study

Turnkey activity provides a regular source of income for people in the rural areas, working on a full or part time basis. However, in the recent years, several entrepreneurs have also entered the field. These entrepreneurs usually employ a team of masons and other workers to install biogas plants on a large scale, often up to 500 plants, compared to TKWs who install up to 200 plants. They invest some capital also to cover the initial costs. In some parts of Maharashtra, and Gujarat this approach has yielded good results.

Here, the case of a private entrepreneur in Kolhapur, Maharashtra has been presented to provide an illustration of the operations and economic gains of this activity. This entrepreneur installs about 400 ***Deenbandhu*** plants every year—on an average, 200 are of 3 m^3 capacity and the rest are of 4 m^3 capacity. He invests money to meet the working capital requirements, and no bank loans are taken.

Obviously, the figures in other cases will differ depending on the type of the beneficiary, local cost of different materials, etc.

	Rate	3 m³		4 m³	
		Quantity required	Total cost (*Rs*)	Quantity required	Total cost (*Rs*)
Bricks	Rs 750/ 1000 nos	1300	975	1600	1200
Sand	Rs 1200/ truck	0.5	600	0.5	600
Cement	Rs 115/ bag	16	1840	22	2530
Stone chips	Rs 300/ truck	0.33	100	0.33	100
AC pipe	Rs 8/ft	10	80	10	80
Stone slab	Rs 100/ slab	3	300	3	300
Stove	Rs 400/ stove	1	400	1	400
Pipe fitting & accessories			200		200
Mason charges			400		400
Misc.			200		200
Total			5095		6010

Thus the total plant cost for a 3 m^3 plant is Rs 5095 and for a 4 m^3 plant is Rs 6010. The subsidy amount available for both these capacities is Rs 2000. Thus the beneficiary has to invest a sum of Rs 3095 and Rs 4010 for a 3 m^3 and 4 m^3 plant, respectively.

As subsidy disbursement takes about two months, a working capital for two months is the minimum capital requirement for the entrepreneur. In two months, he can install approximately 100 plants. Assuming that out of these, 50 are of 3 m^3 and 50 are 4 m^3 capacity, the total expenditure on plant construction would be as follows:

50 x Rs 5095	=	Rs 254 750
50 x Rs 6010	=	Rs 300 500
Total		**Rs 555 250**

A major part of the working capital requirement is met through informal credit arrangements with dealers of construction materials. As these operate on goodwill and the repayment period is seldom more than a month, interest charges on these transactions are neg-

ligible. The monetary value of these savings can be approximated as follows.

A.	*Material on credit*	
	Cement	Rs 175 000
	Bricks	Rs 100 000
	Sand	Rs 60 000
	Stove and pipe fittings	Rs 40 000
B.	*Contribution from beneficiaries*	
	for pit-digging @ Rs 700/plant	Rs 70 000
C.	*Savings from mason charges*	Rs 20 000
	(masons are paid only half their wages in the beginning)	
	TOTAL	**Rs 465 000**

The balance of the working capital requirement of Rs 90 250 (Rs 555 250 less Rs 465 000) has to be met by the turnkey worker in a period of two months.

An estimate can also be made of the annual expenditure incurred by a turnkey worker on supervision and maintenance. Given that 400 plants are constructed during a year, at any given point of time (after the initial two years), a turnkey worker will have to supervise 1200 plants. Assuming that 50% of the turnkey fee is paid to him initially and the balance after completion of the warranty period, his gross annual earnings from supervision fee can be worked out as follows.

Year	No. of plants constructed	Turnkey fee
Year I	400	250 x 400
Year II	400	250 x 400
Year III	400	250 x 400+ 250 x 400*
Year IV	400	250 x 400+ 250 x 400**

* balance of turnkey fee for plants installed in Year I
** balance of turnkey fee for plants installed in Year II

From this, he has to meet the working capital requirement as well as the cost of supervision. A break up o the annual cost of supervision is given on the followin; page.

Annual expenditure on supervision	
Supervision charge for self (@ Rs 1000 per month)	Rs 12 000
Fuel and other costs on visits (@ Rs 20 per visit)	Rs 1 920
Wages to assistants (@ Rs 300 per month per person)	Rs 10 800
TOTAL	**Rs 24 720**

On an average, the turnkey entrepreneur makes two visits a week for supervision, and has hired three local persons to assist him.

Thus, the income from turnkey fee is about Rs 200 000 per annum from which he has to meet the expenditure on supervision and also his working capital requirements. As can be seen, he can earn a decent surplus income after meeting these requirements, which would be around Rs 75 000 from the third year onwards.

Need for expanding the entrepreneurial base

The turnkey approach has clearly become the main factor contributing to the success of NPBD in a large measure. This fact has been well recognised by MNES and the state implementing agencies, which are now encouraging 75% of the total target in NPBD to be met through various categories of TKWs. Also in a recent policy shift, MNES, in keeping with the new economic policy of the country, has initiated several fundamental changes in the promotion of renewable energy technologies including biogas, with basic thrust on commercialization. Under the new dispensation, the role of beneficiaries has been enhanced by substantially reducing the subsidy component, which would be completely withdrawn from 1995–96; and to provide thrust to the market orientation, publicity and awareness campaigns using multi-media forms are also being taken up on a major scale. On the operational side, procedures for release of funds for various components of NPBD are being simplified to ensure timeliness in completion of targets. In view of these important developments, the targets of biogas plants have been revised

upwards; the target for 1993–94 is now 200 000 as against the earlier 135 000, and the Eighth Plan target is 1 000 000 instead of 740 000. The new policy also corroborates the idea of 75% of the target to be achieved through TKWs and voluntary organisations.

While all these measures are quite progressive, it is important to expand the entrepreneurial base further. As of now, only a fraction of the huge potential that exists for biogas has been realised, and if this indubitable potential has to be translated into real benefits, it is imperative that steps be taken to attract not only individuals who function as TKWs, but also more entrepreneurs into the fold of NPBD, who can bring additional investment into the sector and install biogas plants in a big way. For this, an appropriate regime of monetary and fiscal incentives needs to be developed to be offered to prospective TKWs and entrepreneurs, as is being done in the case of many other renewable energy technologies. Such a move would not only create wide employment opportunities in the rural areas for masons, educated but unemployed youth, etc., but the spread of biogas technology on a large scale can also result in use of biogas for shaft power and electricity generation, which can spur the development of income-generating activities like small-scale industries.

Thus, the future is extremely encouraging for biogas technology, and by involving more and more people to take up biogas installation as a commercial proposition, NPBD can become a pivot for rural development.

Material requirements for *KVIC* plant			
Capacity	2 m³	3 m³	4 m³
Materials required for construction			
1) Bricks (nos)	2 060	2 270	2 510
2) Sand (m³)	1.75	2.20	2.40
3) Stone chips 0.5" or 0.75" (m³)	0.60	0.85	0.95
4) Cement (bags)	11	15	16
5) AC Pipe 100 mm internal diameter (R.M)	3.04	3.70	4.90
Materials required for central guide frame			
1) 35 x 35 x 4 or 5 mm angle iron (R.M.)	10.90	11.90	12.70
2) MS pipe 40 mm diameter (R.M.)	1.85	2	2.05
3) Square plates 250 x 250 x 6 mm (nos)	2	2	2
4) 14 mm diameter and 32 mm long bolts with nuts (nos)	16	16	16
Materials required for gas holder			
1) 35 x 35 x 4 or 5 mm angle iron (R.M.)	16.80	19.40	21
2) MS pipe 50 mm internal diameter (R.M.)	1.15	1.15	1.25
3) 250 mm dia and 6 mm thick flange plate (nos)	2	2	2
4) Flats 40 x 6 mm thick (R.M.)	4.20	4.15	4.30
5) Gas outlet pipe flange 25 mm diameter (nos)	1	1	1
6) GI Bend 25 mm diameter (nos)	1	1	1
7) Heavy duty gas valve 25 mm diameter (nos)	1	1	1
8) Union joint 25 mm diameter (nos)	2	2	2
9) Pipe nipple 25 mm diameter, 10 mm long (nos)	1	1	1
10) Pipe nipple 25 mm diameter, 150 mm long (nos)	2	2	2
11) Clips (nos)	2	2	2
12) 3 metre polythene or reinforced rubber pipe 25 mm diameter (nos)	1	1	1
13) 2.50 mm thick (12 gauge) mild steel sheets (2.5 m x 1.00 m) (nos)	2 1/4	3	3 1/4

Material requirements for *Deenbandhu* biogas plant

Plant capacity	2 m³	3 m³	4 m³
Bricks (Class I) (nos)	1000	1300	1600
Cement (bags)	14	16	22
Stone chips (cu ft)	40	50	60
Sand (cu ft)	40	50	60
Coarse sand (cu ft)	40	50	60
GI pipe $^1/_2$" diameter with sockets (inch)	7	7	7
AC pipe 6" diameter (ft)	6	6	6
Iron bars (6 mm diameter) for outlet tank cover (kg)	7	10	12
Paint (litre)	1	1.5	2

Material requirements for *Janata* biogas plant

Material	2 m^3	3 m^3	4 m^3
Bricks (Class 1)(nos)	1500	2500	3500
Cement (bags)	20	25	30
Sand (m^3)	2	2.3	3.6
Coarse sand (m^3)	0.85	1.15	1.6
Brick ballast (m^3)	1	1.15	1.42
Pebbles (m^3)	0.1	0.1	0.3

Material requirements for *Pragati* biogas plant

Capacity	2 m^3	3 m^3	4 m^3
1) Bricks (nos)	700–750	1200–1250	1775–1825
2 Cleared and screened sand (m^3)	1.65	1.8	4
3) Stone metal (25 mm to 40 mm gauge)	0.95	0.98	1.7
4) Cement bags (nos)	9.5	18	21

Note: Gas holder height is 100 cm

State Nodal Departments/Agencies for NPBD

Andhra Pradesh	Non-conventional Energy Development Corporation of Andhra Pradesh, 5–8–207–2, Pisgah Complex, Nampally, Hotel Yatrik Compound, Hyderabad 500 001
Arunachal Pradesh	Directorate of Agriculture, Govt. of Arunachal Pradesh, Itanagar 791 111
Assam	Department of Rural Development, Govt. of Assam, Sethi Bhawan, 7th Floor, G.S. Road, Bhangagarh, Guwahati 781 001
Bihar	Bihar Renewable Energy Development Agency, 18 Aniket Housing Society, Kidwaipuri, Patna 800 001
Goa	Directorate of Agriculture, Govt. of Goa, Panaji 403 001
Gujarat	Gujarat Agro-Industries Corporation, Khet Udyog Bhawan, Opp. High Court, Navrangpura, Ahmedabad 380 014
Haryana	Directorate of Agriculture, Govt. of Haryana, Chandigarh 160 001
Himachal Pradesh	Directorate of Agriculture, Govt. of Himachal Pradesh, Nalagarh House, Shimla 171 002

Jammu & Kashmir	Department of Agriculture, Govt. of Jammu & Kashmir, Srinagar 190 001
Karnataka	Department of Rural Development & Panchayati Raj, Govt. of Karnataka, Secretarial Multistoreyed Building, III Stage, III Floor, Bangalore 560 001
Kerala	Department of Agriculture, Govt. of Kerala, Vikas Bhawan, Thiruvananthapuram 695 001
Maharashtra	Department of Rural Development, Mantralaya, Bombay 400 032
Madhya Pradesh	Madhya Pradesh Agro Industries Corporation, GTB Complex, T T Nagar, Bhopal 462 003
Manipur	Department of Science, Technology and Environment, New Secretariat Complex, Govt. of Manipur, Imphal 795 001
Meghalaya	Meghalaya Non-conventional Energy & Rural Development Agency, Lower Lachaumierre, Opp. P&T Dispensary, Shillong 793 001
Mizoram	Directorate of Animal Husbandry and Veterinary Services, Govt. of Mizoram, Aizawl 796 001
Nagaland	Department of Rural Development, Govt. of Nagaland, Kohima 797 001
Orissa	Orissa Renewable Energy Development Agency, S 59 Mancheshwar Industrial Estate, Bhubaneshwar 751 010

Punjab	Directorate of Agriculture, Govt. of Punjab, Chandigarh 160 001
Rajasthan	Special Schemes & Integrated Rural Development Department, Sachivalaya, Govt. of Rajasthan, Jaipur 302 005
Sikkim	New & Renewable Sources of Energy Department, Govt. of Sikkim, Gangtok 737 101
Tamil Nadu	Department of Rural Development, Govt. of Tamil Nadu Kuralagam 108, Madras 600 001
Tripura	Department of Agriculture, Secretariat, Govt. of Tripura, Agartala 799 001
Uttar Pradesh	Department of Rural Development, Govt. of Uttar Pradesh, Jawahar Bhawan, Lucknow 226 001
West Bengal	Department of Science and Technology and NCE Sources New Secretariat Building, Calcutta 700 001
Andaman & Nicobar Islands	Development Commissioner, Port Blair 744 001
Chandigarh	Department of Rural Development, Chandigarh Administration, Chandigarh 160 001

Dadra and Nagar Haveli	Animal Husbandry-cum-Veterinary Officer, Silvasa 396 230
Delhi	Delhi Energy Development Agency, 11 Lancers Road, Timarpur, Delhi 110 007
Pondicherry	Directorate of Agriculture, Pondicherry 605 001

List of biogas accessory manufacturers

M/s Sunflame Industries Pvt. Ltd
Shed No. 2, Plot No. 58
12/6 Mathura Road, P.O. Amar Nagar
Faridabad 121 003
Haryana

M/s Gas Chemical Industries Pvt. Ltd
Budshah Chowk, Amnakadal, Srinagar
Jammu & Kashmir

M/s Sweet Home Appliances Pvt. Ltd
3-E/16, B.P.N.I.T., Faridabad 121 001
Haryana

M/s Associated Engineering Works
Chivatam Road , Tanuku 534 211
Andhra Pradesh

M/s Agriculture Associates
Station Road, Alwar 301 001
Rajasthan

M/s Rupak Enterprises
1/146 Vishwas Nagar, Shahadra
Delhi 110 032

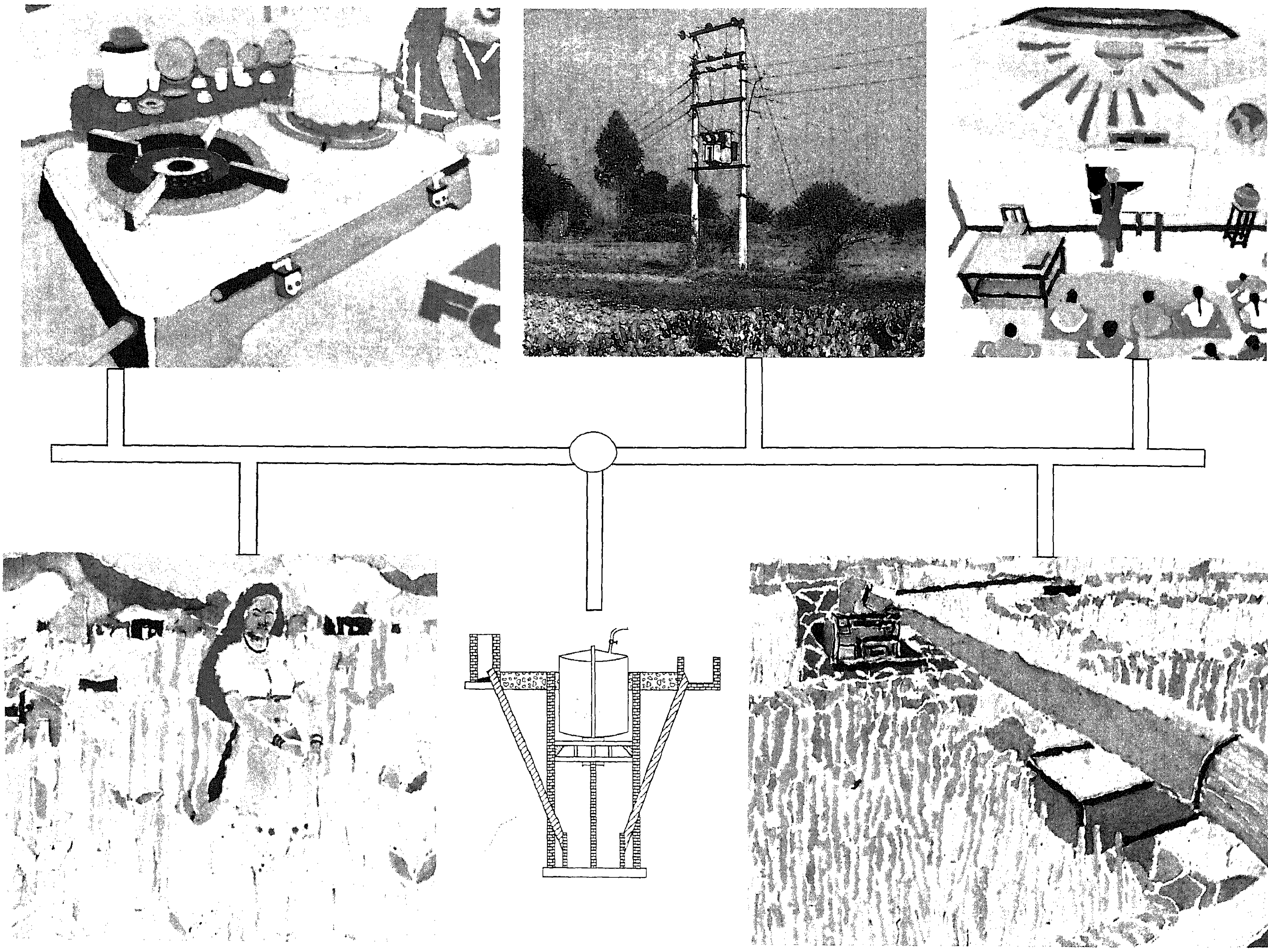
M/s Mech-ci-co 1-7, GIDC
Industrial Township Vatwa, Ahmedabad 382 445
Gujarat

M/s Batra Investments Pvt. Ltd
14/1 Mathura Road, P.O. Amarnagar, Faridabad 121 003
Haryana

M/s Baroda Appliances
886/A, G.I.D.C. Makarpura, Baroda 390 010
Gujarat

M/s Tulsi Domestic Appliances
30-A, Old Industrial Area, Alwar 301 001
Rajasthan

M/s Mitaso Appliances Ltd
Plot No. 63, Sector 6, Faridabad 121 006
Haryana



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9 Jor Bagh, New Delhi 110 003